

Tuberculosis in the Yungas Area of Bolivia

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TUBERCULOSIS continues to be a major cause of morbidity and mortality in the developing world despite modern chemotherapy. There is a recognized need to develop inexpensive and effective techniques for the delivery of tuberculosis control services. Low government revenues, low health budgets, frequent administrative changes, and pressures to channel available resources into curative rather than preventive medicine have continuously hampered efforts in tuberculosis control.

In Bolivia, tuberculosis is the leading specific infectious disease reported as a cause of death among adults. The estimated mortality rate is 125 per 100,000, and the prevalence of active disease is approximately 1.8 percent (unpublished report, 1969, Ministry of Public Health, La Paz). The

high prevalence of tuberculosis in most areas was confirmed by epidemiologic studies undertaken by the Research Institute for the Study of Man (1) in 1967 in various ecological zones of the country.

Because of this background, the U.S. Peace Corps and the Bolivian Ministry of Public Health (MPH) jointly undertook a 2-year pilot tuberculosis control program, during 1967-69, using Peace Corps volunteers. It was hoped to determine whether properly trained and supervised lay personnel could effectively and economically control tuberculosis.

Methods

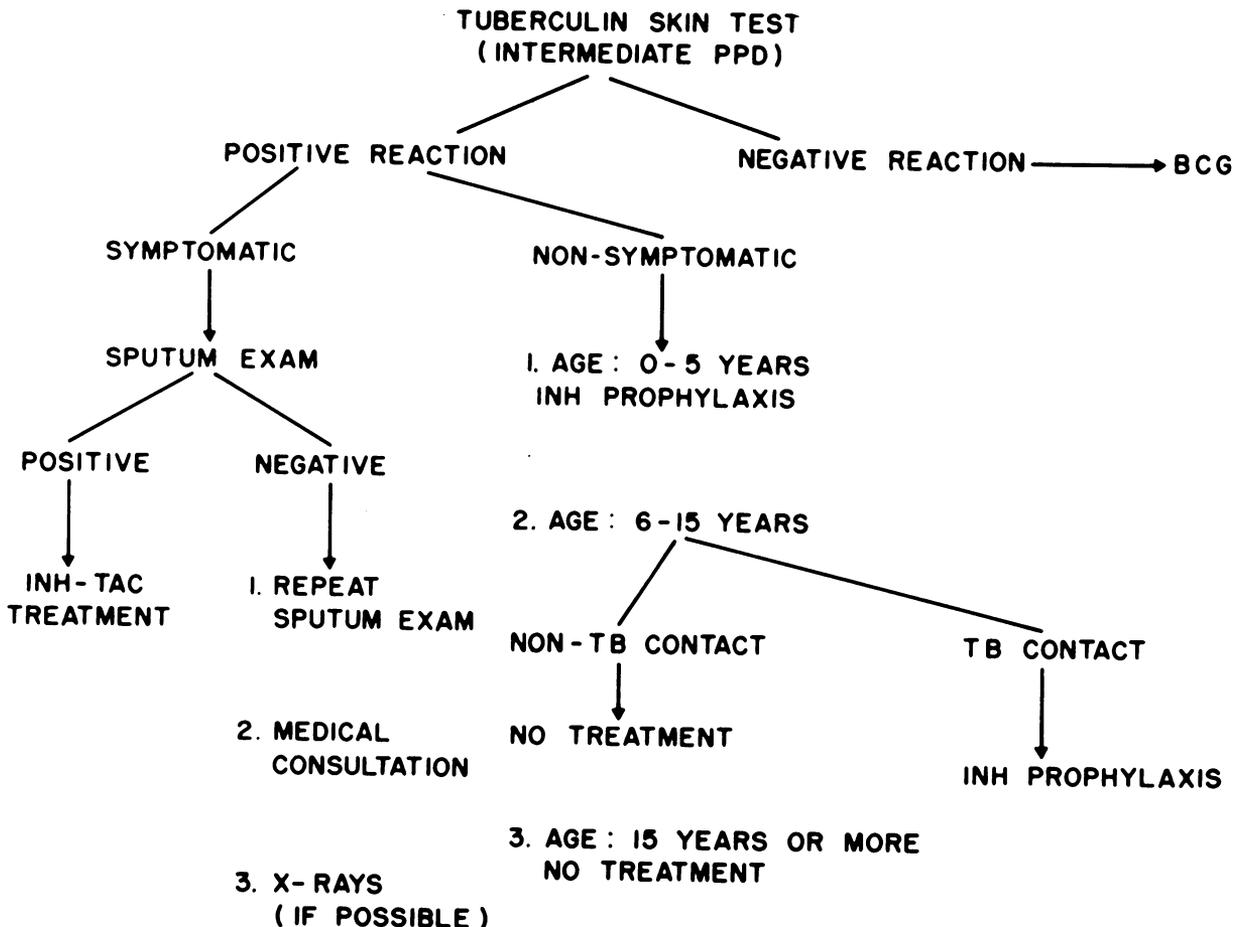
The Yungas, a well-defined geographic area with a relatively stable population of 50,000, was chosen as the site for the pilot program. Its location near the administrative center and capital city, La Paz, facilitated logistics and supervision. It is a tropical to sub-tropical mountainous area, peopled predominantly by Aymara Indian farmers

who have small and poorly ventilated mud-brick and plaster houses.

The immediate objective of the program was to break the chain of transmission of the tubercle bacillus by finding and treating persons with active disease while protecting uninfected persons with BCG vaccine. The protocol followed is summarized in figure 1. All persons contacted were tested intradermally with tuberculin purified protein derivative (PPD), RT-23, two-test units, and those with an induration of 10 millimeters or more after 48 to 72 hours were questioned about symptoms of tuberculosis. Those whose history indicated possible tuberculosis were followed up by direct sputum smear microscopy for acid-fast bacilli.

Persons with suspected but unconfirmed disease received medical consultation or X-ray examination, or both, when possible. When a positive diagnosis of tuberculosis was made, the patient was given a supervised course of isoniazid and

Figure 1. Flow chart for tuberculosis control in the Yungas





A typical small agricultural community in the Yungas, with houses scattered among steep hillside fields of coffee, citrus fruits, and coca

thioacetazone. An asymptomatic patient with a positive skin test received prophylactic treatment with isoniazid if 5 years old or under, or if 6–15 years old and a contact of a person with active disease. Those negative to PPD were given intracutaneous lyophilized Japanese BCG vaccine.

Thioacetazone, a semithiocarbazone studied and used extensively in Africa and Asia (2–9), was selected as the drug of choice for combined therapy with isoniazid because of its proved effectiveness and low cost (\$2.30 per patient per year). A single tablet of 300 mg of isoniazid combined with 150 mg of thioacetazone taken daily eliminated complex drug schedules. The results of toxicity and acceptance trials, carried out in both hospitalized patients and outpatients in Bolivia (unpublished data gathered jointly by the Peace Corps and the Ministry of Public Health in 1966), and the results of extensive use in India and Africa revealed that thioacetazone-isoniazid could be safely used as the standard therapeutic

regimen for children over 5 years of age and adults.

X-ray equipment was extremely limited. Except for occasional diagnostic problems and one diagnostic and evaluative tour in which the MPH's portable equipment was used, X-ray techniques were not utilized.

Manpower was supplied by 28 Peace Corps volunteers, who underwent a rigorous 3-month training program before assignment in the field. All were college graduates with little or no training in biological sciences. They were supervised by both Peace Corps and MPH personnel. Supplies were obtained by funds made available by a grant from the U.S. Agency for International Development and from the MPH's own limited resources.

In this report we present data concerning the extent of coverage achieved by the program, preliminary treatment data, and epidemiologic data generated during the course of the program.

Results

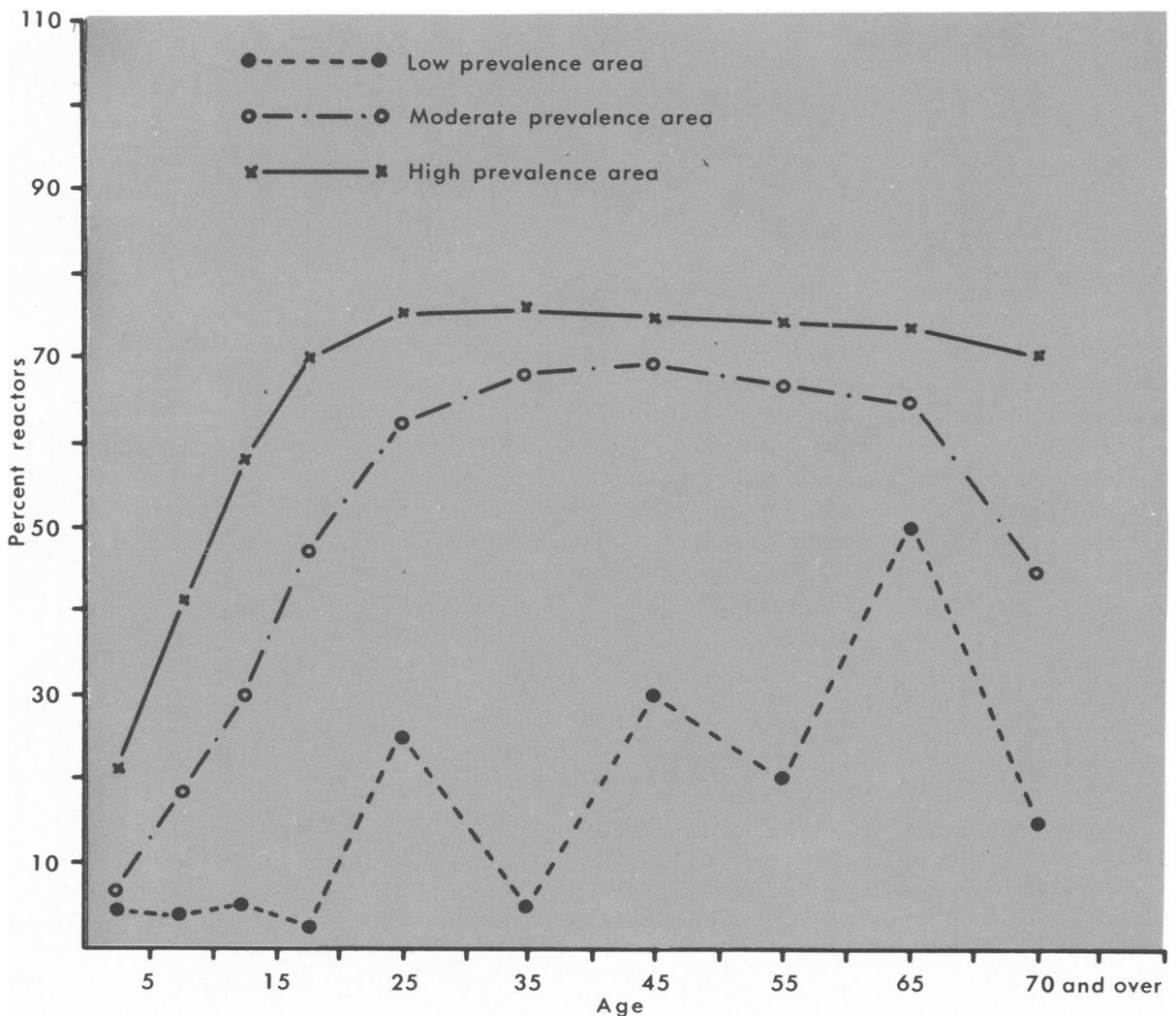
Skin test results obtained during the program are summarized in table 1. A total of 40,153 persons were contacted; 38,197 skin tests were applied, of which 33,481 (87.6 percent) were

read and 16,674 (49.8 percent of those read) were positive. The remaining 1,956 consisted of persons who were contacted by the volunteers and not skin tested for various reasons, including a few with active disease and persons in remote

Table 1. Results of tuberculin skin testing program in the Yungas area of Bolivia

Prevalence area	Number people contacted	Number people tested (PPD)	PPD tests read		PPD positive	
			Number	Percent	Number	Percent
Low.....	1,377	1,371	1,137	82.9	160	14.1
Moderate.....	14,449	14,077	12,243	86.9	5,193	42.4
High.....	24,327	22,749	20,101	88.3	11,321	56.3
Total.....	40,153	38,197	33,481	87.6	16,674	49.8

Figure 2. Tuberculin age profiles



areas who received BCG vaccine without prior skin testing. Age-specific reactor rates are presented in figure 2.

Based on skin test reactivity rates in the 0-14 age group, the Yungas was divided into three geographically distinct areas: (a) high prevalence, more than 25 percent positive skin tests, (b) moderate prevalence, 10-25 percent positive skin tests, and (c) low prevalence, less than 10 percent positive skin tests. The prevalence area sites and the positive reactor rates in the 0-14 age group were as follows.

Site	Reactor rate (percent)
Low prevalence:	
Suapi	5.2
Moderate prevalence:	
Santa Fe	16.2
Caranavi	16.2
Choro	23.8
High prevalence:	
Ocobaya	26.2
Villa Aspiazu	27.8
Tajma	31.4
Arapata	33.3
Huancane	35.6
Irupana	36.4
Cruz Loma	40.0
Guavrapata	42.8
Trinidad Pampa	44.0
Coscoma	44.0
Chulumani	48.7
Coroico	49.3
Coripata	56.0

The frequency distribution of PPD reactions for each area is presented in figure 3.

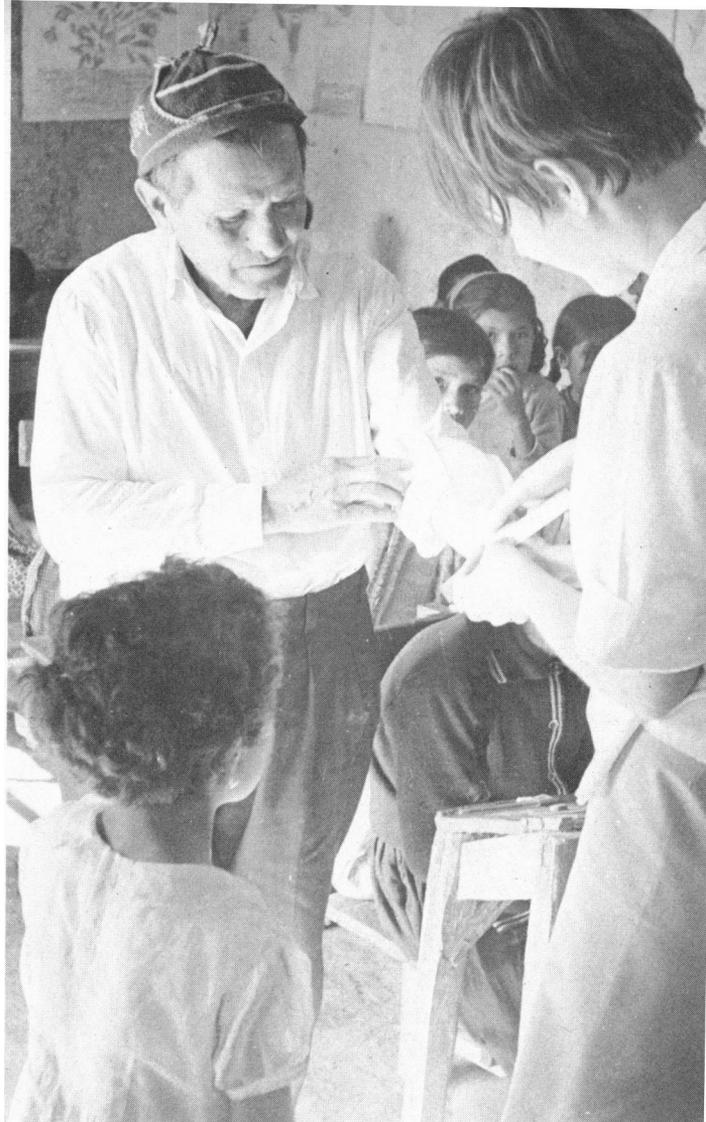
Table 2 summarizes the BCG vaccinations given during the 2-year program. In some isolated areas, the vaccine was given to small groups without prior skin testing. An analysis of first-year data showed that more than 90 percent of the people with negative skin tests at that time had received BCG.

Tuberculosis was diagnosed by sputum examination (746 persons), by X-ray (184 persons), and by local and supervisory physicians on presumptive clinical grounds (295 persons). Active tuberculosis was diagnosed in a total of 1,225

Table 2. BCG vaccinations given during 2 year program, Yungas area of Bolivia

Prevalence area	Number persons PPD negative	BCG vaccinations given	
		Number persons	Percent PPD negative
Low	977	746	76.4
Moderate	7,050	6,466	91.7
High	8,780	8,902	100.0
Total	16,807	16,114	95.9

¹Some persons in this area received BCG vaccine without prior skin testing.



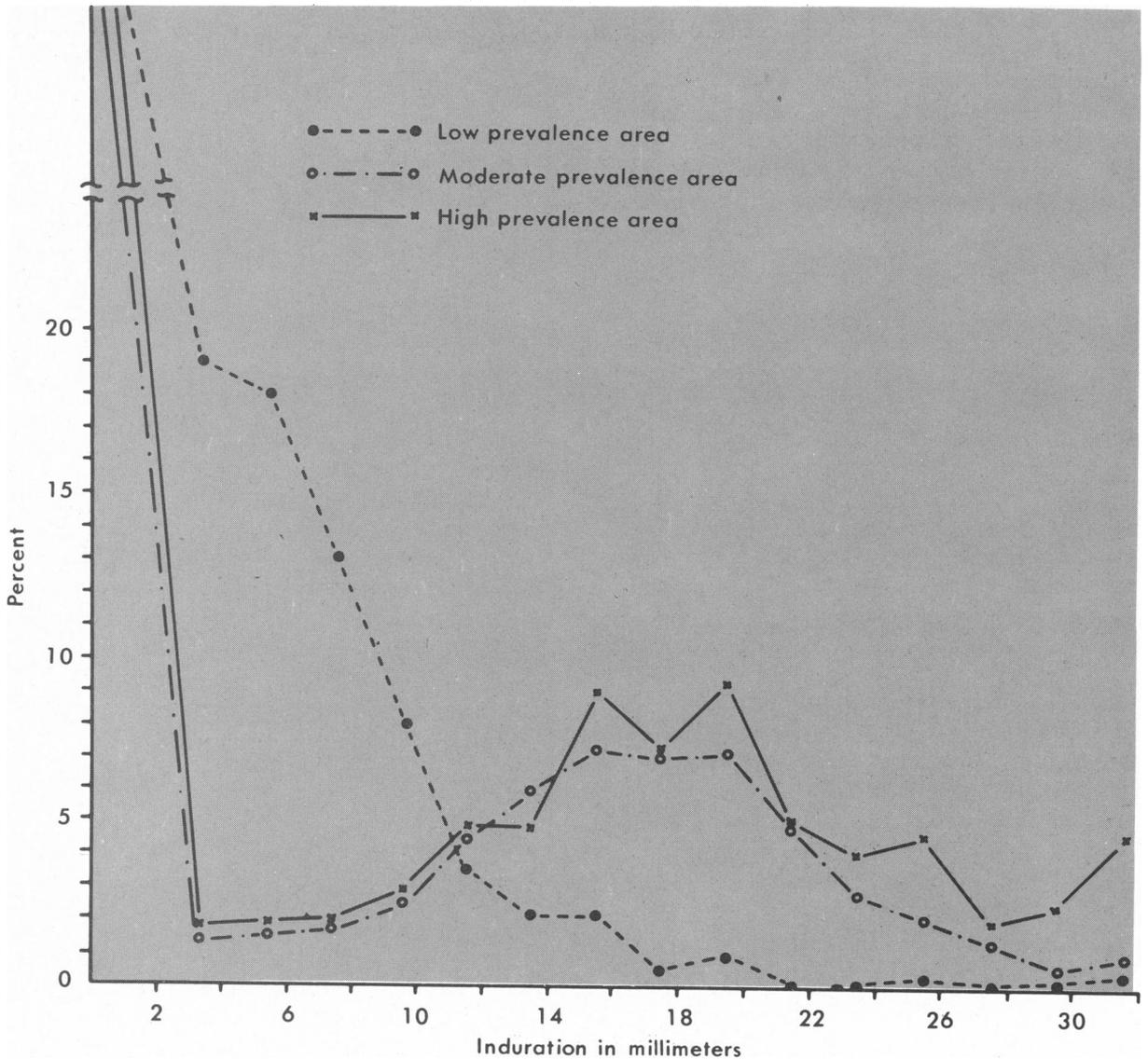
Peace Corps volunteer giving tuberculin test to a resident in the town of Coscoma

persons, or 3.7 percent of the population whose skin tests were read. Approximately 24 percent of the diagnoses were presumptive clinical.

Of the 1,225 persons discovered to have tuberculosis, 1,214 were started on the standard therapeutic regimen. Therapy was abandoned for 2 months or more by 31 percent of the patients. One-fifth of these resumed treatment at a later date. The highest abandonment rate occurred among patients who had been on therapy for 3 months or less. Only 1.5 percent of the patients who abandoned therapy did so because of symptoms of drug toxicity.

Followup sputum examination was done on 346 patients whose sputum smears were positive

Figure 3. Frequency distribution of PPD reactions



after 3 months or more of therapy. Sixty-four percent (222) had converted to sputum negative, as discovered by direct microscopy. X-rays obtained for 159 of the 346 patients at various times during their treatment schedule revealed a 42 percent incidence of advanced cavitory tuberculosis; 83 of the 159 had had previous therapy, frequently short and unsupervised courses of streptomycin or isoniazid.

The Yungas program represented the first large-scale clinical trial of thioacetazone in South America. The Peace Corps volunteers were not highly trained medical observers, and the quality of toxicity records was variable. However, the available records regarding the rate of abandonment of therapy due to drug toxicity and the rate

of sputum conversion indicate that the medication was well accepted and effective. Side effects, mostly minor gastrointestinal disturbances, appeared to be minimal, as shown in the following table.

Reaction	Percent
Gastrointestinal	7.1
Cutaneous hypersensitivity	1.8
Dizziness	1.1
Headache	1.1
Edema	.5
Paresthesia	.2
Jaundice	.2
Nonspecific	.8

Of the 860 children 5 years old or younger with a positive skin test, only 562 (65 percent) were started on therapy with isoniazid. Of these, 239 (43 percent) had abandoned therapy for 2



Peace Corps volunteer giving BCG vaccine in the town of Villa Aspiazu

months or more at the time of data collection.

A total of 1,008 contacts ages 6–15 with positive skin tests were identified. However, only 456 (45 percent) were started on prophylactic therapy. Of these, 187 (41 percent) abandoned therapy. Thus, only 269 (27 percent) of all contacts were receiving therapy according to the norms of the program protocol.

Discussion

A total of 40,153 people were contacted by the volunteers. These people constituted 78 percent of the estimated total population of the area. A total of 33,481 skin tests (88 percent of those applied) were read. Thus 65 percent of the estimated population was adequately screened for tuberculosis infection. Skin testing was continuing at the time of data collection, and the final figures can be expected to be somewhat greater. Despite the low median age of the population, the overall positive reactor rate was nearly 50 percent. More than 90

percent of the negative reactors received BCG vaccine.

The extensive prevalence of tuberculosis infection in this population is demonstrated by the large number of moderately advanced to far advanced cases of active tuberculosis discovered by sputum microscopy and by the high skin test reactivity rates in the 0–14 age group (fig. 2). The areas of highest prevalence were found almost entirely in the older, established regions. The moderate prevalence areas encompassed newly settled colonization areas. Suapi, an established yet low prevalence area, differed from this pattern. This section is somewhat isolated from the rest of the Yungas, having a separate watershed, but identical housing, diet, climate, geography, education, and general habits. The frequency distribution of reaction sizes and the low numbers of cases of active disease uncovered suggest the presence of an atypical mycobacterium which may have endowed the population of Suapi with a degree of natural immunity.



An Indian mother with her two children on a road in the Yungas

A satisfactory percentage of patients who were started on treatment continued their therapy. The volunteers tried to see each patient monthly to review treatment progress and to provide a new supply of drugs. The geographic isolation of the patients made it difficult to supervise their therapy, however, and the volunteers' preference for case discovery rather than case followup hampered attempts to improve followup efforts. Rapid improvement often led to cessation of treatment by symptom-oriented patients. The observed abandonment rate was not, in fact, much higher than that observed in the intensely supervised programs conducted by Moodie in Hong Kong (10). We can only surmise that because the volunteers were in general well-liked and respected, lived for 2 years in the small communities where they were working, and often had informal contacts with their patients, their pressure on patients to continue therapy was substantial. A small percentage of patients discontinued therapy be-

cause of drug intolerance. The program supervisors concluded that the therapeutic regimen was safe, practical, inexpensive, and acceptable.

During the program, an evaluation of the Peace Corps volunteers' skills was conducted by the MPH. During a limited Yungas tour in the second year of the program, the MPH mobile X-ray team took as many X-rays as possible as a screening procedure for the entire town of Irupana, where volunteers were working.

Approximately 30 percent (1,440) of the estimated population of 4,800 in Irupana were X-rayed, and 36 persons with new cases of tuberculosis were discovered. However, only 7 of these 36 persons had been screened previously without having their tuberculosis diagnosed by the volunteers. The volunteers, then, had diagnosed 70 of 77 cases of tuberculosis in the population they had contacted to that point.

MPH personnel also skin tested a sample of the

Irupana population that had previously been skin tested by the volunteers. There was some slight variation in indurations recorded, but in no case was the difference one which would have placed the patient in a different diagnostic category.

Accompanying the portable X-ray unit was an MPH laboratory technician who, unannounced, visited each volunteer and reviewed all of the sputum smears on hand. Of a total of 993 slides reviewed, there was disagreement on only 38, or 3.8 percent, about the presence or absence of tubercle bacilli and their relative numbers. Another 4.2 percent of the slides were judged to be poorly stained. It was the opinion of all supervisors that the volunteers were technically competent.

Conclusion

A group of properly supervised, technically trained Peace Corps volunteers successfully implemented a relatively complete pilot program of tuberculosis control in a small area of Bolivia. They proved to be enthusiastic and competent, and they achieved results that compare favorably with work done by professionals in other parts of the world.

The reliance on sputum smears rather than X-ray for casefinding, the use of thioacetazone combined with isoniazid as the therapeutic regimen, and the use of professional personnel only in supervisory roles kept costs comparably low. In those parts of the world where tuberculosis continues to be a disease of major importance and where budgets for its control are concomitantly

limited, an expanded role for well-supervised non-professionals with short-term technical training should be explored.

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Between 1967 and 1969 the U.S. Peace Corps, the Bolivian Ministry of Public Health, and the U.S. Agency for International Development cooperated in a pilot project, in the mountainous Yungas area of Bolivia, designed to demonstrate that tuberculosis could be controlled inexpensively by properly supervised lay personnel with short-term technical training.

A total of 40,153 people (78

percent of the estimated population) were contacted by specially trained Peace Corps volunteers; 33,481 skin tests were given and read. The positive reactor rate was about 50 percent. More than 90 percent of the negative reactors received BCG vaccine. Active tuberculosis was diagnosed in 1,225 persons, and 1,214 were started on therapy. Overall, less than 30 percent abandoned therapy. Drug toxicity was not a major problem.

An area of low incidence was discovered, and the data suggest the presence of hypersensitivity to an atypical mycobacterium in that area.

It was concluded that isoniazid combined with thioacetazone is an acceptable therapeutic regimen for extensive use in Bolivia, and that volunteer lay personnel can successfully implement an inexpensive program of tuberculosis control.